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Characterization and utilization of kepok banana bark powder (*Musa balbisiana* Colla) as absorbent of metal ions Pb(II) & Cd(II) in aqueous solution

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ABSTRACT

Characterization of kepok banana (Musa balbisiana Colla) bark powder to determine the chemical composition and functional groups which play a role in the absorption of Pb(II) and Cd(II) metal ions in aqueous solution, has been performed. The functional groups owned based on FTIR are hydroxy group at wave numbers of 3422.77 cm^{-1}, alkanes at wave numbers of 2919.27 cm^{-1}, and carbonyl at wave numbers of 1636.50 cm^{-1}. To determine the absorption capacity of Pb(II) and Cd(II) metal ions by banana bark powder,it was studied the effect of pH, particle size, weight of biomass and contact time. The results showed that the maximum capacity (Q_m) for Pb(II) metal ion is 10.9215 mg/g and Cd(II) metal ion is 2.8275 mg/g, obtained at pH 4, contact time of 90 minutes and mass of 0.1g for both metal ions,whilethe particle size is 180 µm for Pb(II) metal ion and 150 µm for Cd(II) metal ion. Theinitial concentrations for Pb(II) and Cd(II) metal ions are 50 mg/L and 15 mg/L, respectively. Based on the data obtained, it can be concluded that kepok banana bark powder can be used as biosorbent for the absorption of metal ions in aqueous solution.

Keywords: Kepok Banana (*Musa balbisiana* Colla) Bark; Pb(II) and Cd(II)Metal Ions; FTIR; Absorption.

INTRODUCTION

Heavy metal is a type of dangerous pollutants in the environment because it is toxic and is resistant to dust. Dust resistant properties that causes heavy metals accumulating in the waters when absorbed and accumulate in the human body can interfere with health in the long term can lead to death [1]. Heavy metals Pb and Cd is a heavy metal that can not be broken down by natural processes and can endanger health [2-3]. One other alternative in the treatment of waste containing heavy metals is the use of biological materials as adsorbent. This process is referred to as biosorption [4]. Components that play a role in the process of heavy metal adsorption with adsorbent materials is the presence of biologically active groups that exist in such material. Groups that include acetamido group in chitin, amino and phosphat on nucleic acids, amido group, amino, sulphydryl and carboxyl on the protein and polysaccharide hydroxyl groups. Clusters is what will attract and bind metals in the biomass[5]. In the banana stem contains 50% cellulose and 17.8% lignin [6]. In society, harvest banana fruit only old used for personal consumption or sale. While after harvesting banana the stems, barks, fronds and leavesjust stacked or through away that gradually becomes waste and can pollute the environment. In order to increase the benefit of banana waste, characterization of functional group in banana bark powder by FTIR was done and the ability of banana bark (*Musa balbisiana* Colla) to absorpt Pb (II) and Cd (II) in aqueous solution is a goal of this research. Optimum condition of absorption Pb (II) and Cd (II) by banana bark 1 powder was evaluated with some parameters such as the effect of pH, mass of biosorben, particle size and contact time on absorption capacity. Concentration of Pb and Cd were detected by Atomic Absorption Spectrometer.

EXPERIMENTAL SECTION

Sample plant material
Kepok Banana Bark (*Musa balbisiana* Colla), the identification was carried out in HerbariumLaboratory ofAndalas University (ANDA) with theidentification number is 178/K-ID/ANDA/X/2015.

Instrumentation
The tools used in this study were the analytical balance (Kern andSohn GmbH), rotary shaker (Edmund Buhler 7400 Tubigen), pH meter (Metrohm), Atomic Absorption Spectrometer (AAS; Varian SpektraAA 240 spectrometer), Fourier Transform Infra Red (Unican Mattson Mod 7000 FTIR Spectrometer) and other laboratory glassware.

Chemicals
Materials used in this study were banana bark, aquabidest, Pb $(NO_3)_2$, Cd $(NO_3)_2$, NaOH p.a, HNO_3 65%(Merck), CH_3COOH (Merck), CH_3COONa (Merck), aquadest, filter paper, and KBr pellets.

Procedures
Sample preparations
Banana bark is dried, then ground and sieved with a sieve of 150 µm up into powder. Then activated by means of banana bark powder soaked in a solution of 0.01 M HNO_3 for 2 hours then filtered and rinsed with aquabidest. Subsequently the samples that have been activated can be dried and used as a sample.

Optimum Condition of Absorption PbII) and Cd(II) by Banana Bark Powder
The pH effect on Pb(II) and Cd(II) absorption
To determine the effect of pH was done by 20 mL Pb(II) 50 mg/L included in a 250 mL Erlenmeyer, with pH 3,4,5, and 6 in each erlenmeyer, acetate buffer and then added to a volume of 25mL. Then insert a 0.1gram sample in each erlenmeyer with a particle size of 150 µm. Stir with a rotary shaker for 90 minutes at a speed of 100 rpm. Then filtered using filter paper and the filtrate analyzed by AAS.

The mass effect on Pb(II) and Cd(II) absorption
Biosorbent form as determination is done by 20 mL Pb(II) 50mg/L included in a 250 mL Erlenmeyer, with a pH optimum of previous experiments, acetate buffer and then added to a volume of 25 mL. Then insert the sample in each erlenmeyer with a variation of mass 0.1; 0:15; 0,2; 0:25; 0.3 grams in each erlenmeyer with a particle size of 150µm. Stir with a rotary shaker for 90 minutes at a speed of 100 rpm. Then filtered using filter paper and the filtrate analyzed by AAS.

The particle size effect on Pb(II) and Cd(II) absorption
For particle size determination was done by 20 mL Pb(II) 50mg/L included in a 250 mL Erlenmeyer, with a pH optimum of previous experiments, acetate buffer and then added to a volume of 25 mL. Then insert the sample in each erlenmeyer with optimum mass of earlier experiments by varying the particle size of 150; 180; and 212 µm. Stir with a rotary shaker for 90 minutes at a speed of 100 rpm. Then filtered using filter paper and the filtrate analyzed byAAS.

The contact time effect on Pb(II) and Cd(II) absorption
For the determination of the contact time is done by 20 mL Pb (II) 50 mg/L included in a 250 mL Erlenmeyer, with a pH optimum of previous experiments, acetate buffer and then added to a volume of 25 mL. Then insert the sample in each erlenmeyer with a mass and the optimum particle size of previous experiments. Stir with a rotary, variation of contact time 30, 60, 90, and 120 minutes with a speed of 100 rpm. Then filtered using filter paper and the filtrate analyzed by AAS. The same procedure was done for Cd(II) metal at each optimum condition, concentration Cd(II) 15 mg/L.

FTIR Analysis
The sample is before and after contacting with the metal were analyzed by using FTIR

RESULTS AND DISCUSSION

Optimum condition of absorption Pb(II) and Cd(II) by banana bark powder
The pH effect on Pb(II) and Cd(II) absorption
At pH absorption determination of Pb(II) and Cd(II) by banana bark powder obtained optimum pH is pH 4 in which the absorptive capacity for Pb(II) amounted to 11.1922 mg/g and Cd(II) of 2.6350 mg/g. The pH value is one of the important variables in the process of biosorption. This is because the pH affects the ionization of functional groups

on the surface of the absorbent. In addition, hydrogen ions alone can compete strongly with the adsorbate [7-8]. Some studies indicate that biosorption at low pH is relatively small. This is due to the low pH increased competence or competition with protons in the active sites of the adsorbent [2, 9-11]. Biosorption process at a pH below 2 reported small because of the competition with the hydrogen ions in the active sites of the adsorbent. The increase in pH will lead to competition with hydrogen decreases, so that the adsorption capacity increases.

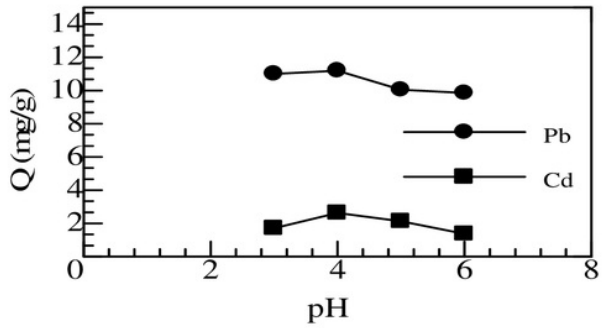

Figure 1.The effect of pH to the absorption of Pb(II) and Cd(II) ions on banana bark powder; 25mL metal ion solution + buffer; Pb(II) concentration: 50mg/L, Cd(II) concentration: 15 mg/L;biosorbent mass:0.1g; contact time: 90 minutes; stirring rate: 100 rpm; particle size: 150 μm

The mass effect on Pb(II) and Cd(II) adsorption

In the determination of the mass of biosorbent absorption of Pb(II) and Cd(II) by powdered bark of the banana gained mass optimum of 0.1 grams where absorptive capacity for Pb(II) amounted to 10.9215 mg/g and Cd(II) of 2.8275 mg/g. When the initial concentration constant and mass increases the absorption capacity will be reduced. [12] who study *Abies nordmanniana*(Stev) also get biosorption capacity of Pb(II) and Zn(II) decreases with increasing mass. [13] studied the *Moldy maizecobs* also get biosorption capacity of Pb(II) and Cu(II) decreases with increasing mass.

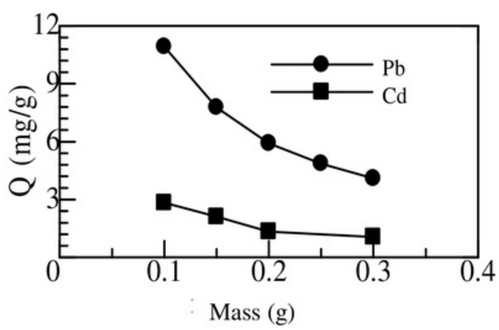

Figure 2. The effect of mass to the absorption of Pb(II) and Cd(II) ions on banana bark powder; 25mL metal ion solution + buffer; Pb(II) concentration: 50mg/L, Cd(II)concentration: 15 mg/L ;pH 4; contact time: 90 minutes; stirring rate: 100 rpm; particle size: 150 μm

The particle size effect on Pb(II) and Cd(II) adsorption

From the data obtained showed adsorbent banana bark powder with a size of 150 µm has the ability to absorb Cd(II) with the highest absorption capacity value of 2,8270mg/g. Percentage of Cd(II) adsorbed inversely related to the large size of the adsorbent. The smaller the diameter of the adsorbent, the percentage decrease in the levels of Cd(II) getting bigger. This is because the smaller the diameter of the adsorbent means the surface area of contact between the adsorbent banana bark powder with metal ions Cd(II) getting bigger. In addition, the surface area is also directly proportional to lots of pores possessed per unit adsorbent particles [14]. Only for Pb(II) there is a difference in the results which to measure biosorbent absorbing metal with a high capacity of 11.1922 mg/g is the size of 180 µm. And for sizes above 180 µm decrease incapacity as well as metals Cd(II).

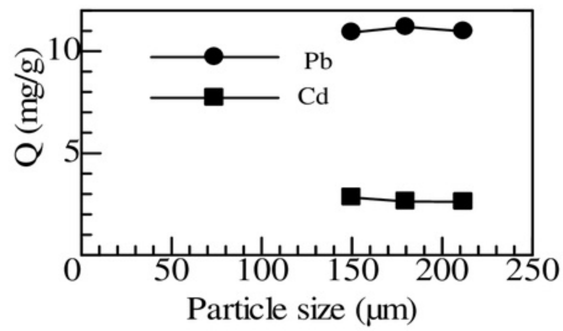

Figure 3. The effect of particle size to the absorption of Pb(II) and Cd(II) ions on banana bark powder; 25mL metal ion solution + buffer; Pb(II) concentration: 50mg/L, Cd(II)concentration:15 mg/L ;biosorbent mass:0.1g; contact time:90 minutes; stirring rate:100 rpm; pH 4

The contact time effect on Pb(II) and Cd(II) adsorption

From the results showed that Pb(II) and Cd(II) adsorbed greater with increasing contact time. This is due to the longer time interaction with adsorbate adsorbent allows the number of collisions that occur so that more adsorbate absorbed. According to the collision theory of reaction speed depends on the number of collisions by one unit of time, the more collisions that occur, the faster the reaction to take place. From the graph above it can be seen rising concentrations of Pb(II) and Cd(II) adsorbed greatest and reached the optimum point is at the 90 minute with a capacity of absorption of Pb(II) 11.7890mg/g and Cd(II) 2.9899mg/g. After the interaction to take place for 90 minutes, the adsorption of metal ions Pb(II) and Cd(II) by a constant powder banana bark powder. This show has achieved a state of equilibrium. Time equilibrium is determined to find out when an adsorbent experiencing saturation so that the adsorption process stopped [15]. Moreover, Sun [16] reported that the metal cadmium biosorption equilibriumin *Aspergillus* also tend to be slower when compared with other metals such as lead.

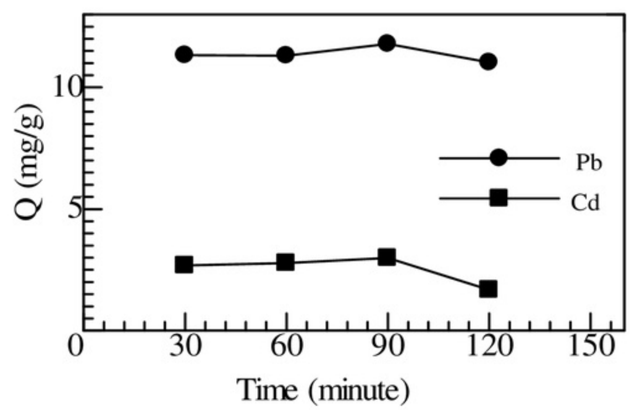

Figure 4. The effect of contact time to the absorption of Pb(II) and Cd(II) ions on banana bark powder; 25mL metal ion solution + buffer; Pb(II) concentration: 50mg/L, Cd(II)concentration: 15 mg/L ;biosorbent mass: 0.1g; pH 4; stirring rate: 100 rpm.

FTIR spectra of banana bark powder

FTIR analysis were indicated hydroxyl group at 3422.77 cm^{-1}, alkanes at 2919.27 cm^{-1}, and carbonyl 1636.50 cm^{-1}

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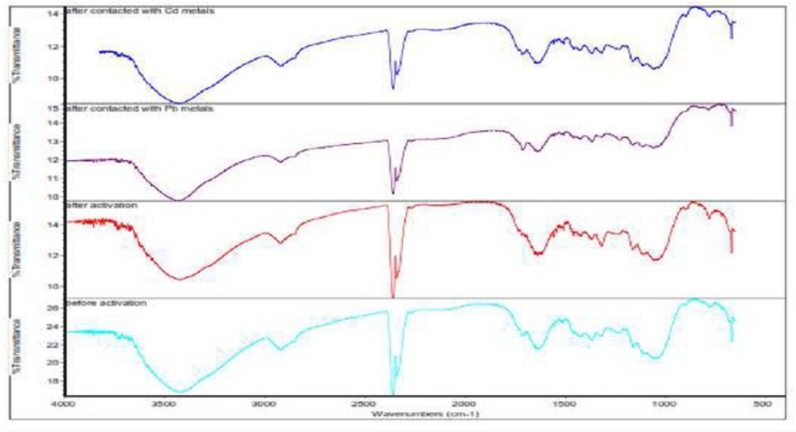

Figure 5. FTIR spectra of banana bark powder : before activation, after activation, after contacted with Pb metals, and after contacted with Cd metals

CONCLUSION

Kepok banana bark powder (*Musa balbisiana* Colla) can be used as an biosorbent for metal ions in aqueous solution. Functional groups that have a role in this absorption were hydroxy and carbonyl groups.

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